

The solar-powered silent partner

By Jim Slater
(with Larry Elliott)

When my wife Jessie and I moved to our new place on the High Desert of Central Oregon, we knew that a steady, reliable supply of water would be our prime consideration. With 160 acres of dry, parched desert, our first major project would have to be a water well.

We had looked long and hard at the lay of the land before we bought it to make sure that a well could be drilled and pumped without bankrupting us.

To our west is an area where deep wells and dry holes are common. We could not afford to end up with either of these. Typically a well in this area ends up at 700 to 800 feet and leaves the land owner with a bill of over \$15,000 even if it's only a dry hole. To the north and south of us steep buttes are dotted with small springs that run cold and clear year round, even during our recent seven-year drought. We were hoping that this high water table could be found somewhere on our place.

Even if we could find water, the next obstacle that would need to be overcome would be that the nearest power line was two miles away and, at \$6 per foot to get it here, this option would be out of the question. Any energy we would use to pump water would either have to be portable (gas, diesel, etc.) and easily purchased or we would have to produce it ourselves. An AC submersible pump and generator was considered first, then a windmill or perhaps a gasoline powered jack pump. At this stage we had not even heard of a solar pump.

Looking for water

Two sites were chosen on our property as likely to have water. A well driller recommended by a friend was called in to look things over. At the

first site he was shown, which happened to be located next to our cistern installed up the hill from the house, he looked at the dark red rock formation and said "Don't look like you will do any good here. I've drilled in this type before and never had any luck." He asked to see something else. At this point our options had just dropped by 50%. I then told him we had picked another area because it was located near a hillside spring and close to the junction of two large gullies that drained hundreds of acres, the only drawback being that it was very remote and near the top of a steep hill. "Well let's see it," he said. Our spirits were lifted when he took a look at some hard grey rock and told us that if he could set up his rig on this remote spot, there would be a good chance of finding water. Since one of my wife's many talents happened to be dowsing, it seemed like a good idea to let her try her hand in verifying the driller's observation. After a few quick passes, Jessie said, "Drill here." As it turned out, they were both right. The well came in at 185 feet and better than 5 gallons per minute. Not only did this solve our water problem, but it also proved we were right to question the conventional "wisdom" of the locals who said it couldn't be done.

Next problem

Now that our first problem was out of the way, we had to face the problem of how to get the water out of the ground and then deliver it many hundreds of feet down to our house and cistern, as well as pasture. Since the well pump would now be situated 950 feet up a steep and fairly inaccessible hill, we didn't feel like having to supply any pump that would need fuel. Packing a gas can uphill on skis or snowshoes just did not appeal to us. We gave some thought to using a

windmill, but the well is protected from the wind. A new source of energy would have to be found.

About this time a friend of ours loaned us a solar products catalog. Little did we know that so many products existed for folks like us who live beyond the grid. After reading the section on water pumping and looking at solar panels and trackers, it all began to sound good. Since all advertising should be taken with a grain of salt, we decided to talk to others who may have already had experience with solar pumping. A rancher friend of ours said that he knew people further east of us who were using a solar pump with good results. A rancher will be the first to tell you if something does or doesn't work. We heard only positive comments, which was what I wanted to hear.

The solution found

A local solar distributor and installer was next contacted. We told him that we wanted to get a solar pump but needed to make sure we got the right one. We had decided on a DC submersible with a passive tracker. He asked if we had considered a jack pump. We replied that we had, but the cost was too high for our budget. He said, "I just happen to have a used jack with a motor and controller I'd like to sell." After spending the rest of the day checking out the jack and doing a lot of arithmetic, we called him back and said, "Let's do it."

The main reason for choosing the jack pump over the submersible, besides the cost, was that should something go wrong with the motor, repairs would be quite easy and relatively inexpensive. In a jack pump the motor is above ground, not in the well. A simple belt and pulley connect the motor to a gear box. A gas motor could be attached if need be, or perhaps a bicycle pulley, although not very practical. Also, by attaching a larger motor and more panels, the out-

put of the pump could be increased in the future if needed.

After a few weeks, we had all the equipment necessary to complete the pump installation. The well driller was called back to help set the pipe and well cylinder, and all went along with only some minor problems. The first time water began flowing out the discharge pipe we knew we had a winner and that at least our first two problems had been overcome.

How it works

For all of you who may not be familiar with the components that make up a complete solar pumping system and have only a little knowledge of how it works, a brief description is in order.

In our system, six used Arco (now Seimens) M-51 photovoltaic panels are wired in series to produce the voltage necessary to drive the motor. These panels are mounted on a Zomeworks passive tracker (requires no electric motors or external power source) which orients the panels toward the sun as it travels across the sky.

The electric power produced by the panels flows to a controller which, in our system, is a 600-watt Australian Energy Concepts Maximizer. This power is then fed to a 1/3 hp permanent magnet motor that drives a 60:1 ratio gear box through a belt and pulley arrangement that also serves to further increase the ratio between motor and gear box rpm. This wide gear ratio serves to keep the pumping action slow and very powerful due to the high torque generated.

The rotary motion of the gear box is then converted to reciprocating up and down motion using an eccentric, in a manner somewhat similar to the method used to drive steam locomotive wheels. This up and down motion is transmitted to a cable and walking beam (very similar to oil field pumps that look like giant prehistoric birds bobbing their heads up and down) that

pulls a 7/16" steel rod up and down inside the well pipe. This rod then drives a piston and cylinder located at the bottom of the well in an up and down motion that lifts water to the surface. The water is truly "jacked" to the surface with each stroke. Our well cylinder travels about 18" with each stroke and with a 1 7/8" piston delivers over 1.5 gallons per minute in full sun.

At some point, we shall increase this production by using a larger cylinder and motor, and by adding two extra solar panels. The tracker we purchased had room for a total of eight panels, so we will have room for them without any modifications. This is something to keep in mind if you may be looking to do as we have done.

The entire pump assembly is housed in a small A-frame shed that serves to keep ice, rain and snow, as well as critters, off the pump. Since we have cattle roaming about our area, a barbed wire fence was built around the pump and the solar tracker to prevent damage. Even if you don't have cattle, deer can do a lot of damage if they decide to use your tracker as a scratching post.

After we were assured we would have a steady supply of pure water, the hardest phase of the entire project had to be tackled. We had to dig a trench and lay pipe the entire distance (over 1000 feet) to our house and cistern. Instead of simply digging trenches and laying pipe, we decided to carefully design the entire system to give us maximum water to several different sites and do it without having our bitter cold winters freeze pipes and leave us without water.

Our water project became a real test of our commitment to living off the grid and on an isolated ranch. Our pipeline had to be laid in a ditch that dropped down a steep slope for over 950 feet and had to be dug through a lot of rock. 250 feet of this ditch had to be dug and backfilled by hand. After all the backbreaking digging was done, 1 1/4" PVC pipe was laid down the entire length. Care was

taken to ensure that all sections would be self draining each night.

The pipe terminates at an underground 1800 gallon cistern. The cistern is located about 300 feet from the house with a drop of about 50 feet. A separate pipe comes out the top of the cistern to act as an overflow. This overflow is piped past the house to the barnyard where it fills a stock pond and stock tank. We use a system of valves to direct this water. A 5-foot piece of 12-inch water main fits around both valves and stands vertically above them. The top is plugged with foamboard and covered with a piece of plywood. This valve box is insulated from freezing by filling large plastic garbage sacks with fiberglass insulation. Using duct tape to hold it together, I rolled up a two and one half foot section of unfaced insulation to about a 12-inch diameter coil and placed it in the garbage sack. This insulates from ground level to the top of the valves.

Since our system is gravity fed, our water pressure at the house is about 22 P.S.I. This is somewhat lower than standard city water pressure, but serves us very well and is more than enough to allow use of a tankless water heater. We have kept all of our pipe sizes a little larger than required to lower the friction and give better water delivery.

We had one of the coldest winters on record this year, and no part of the water system froze. The jackpump output was enough to keep us and our livestock well supplied with water even though we hardly saw the sun for the two months of December and January. We are very happy with our water system. Last summer we were blessed with a beautiful vegetable garden. Carrots, potatoes, bush beans, corn, strawberries, pumpkins, onions, cukes and more all grown with water pumped by the sun and on land that, until then, was dry and brown and stripped of moisture. The horses now drink cold, clear water on the hottest

days of summer and splash in their own pond to cool themselves.

We did a lot of planning and hard work to accomplish these things, but it has all been worth it.

The Maximizer, or LCB, used in this system is without a doubt the most important component of all. This controller can be best described as an electronic gearshift. It converts amps to volts or vice versa. In our system, six photovoltaic panels, each producing 2.3 amps at about 17.3 volts, are wired in series (positive to negative, etc.) to give a total of 2.3 amps (remember, in series circuits only the voltage adds) at about 104 volts. In very bright sun this voltage and current can be even higher.

Since our motor requires around 90 volts to operate at full speed, the Maximizer converts (using switching technology found in computers) the excess voltage to current to supply the three amps needed by the motor. This allows the pump to operate at maximum efficiency even in low sun conditions. On overcast days or when a cloud passes overhead the voltage of the panels stays around 96 volts, but the amps decrease. In this condition the motor would normally stop. The Maximizer now "shifts gears" and supplies additional amps at a lower voltage and keeps the pump running. The only time our pump stops is in total darkness or in groundfog. D